The CRUSHED STONE JOURNAL

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Nelson S. Greensfelder

Keep Them Interested

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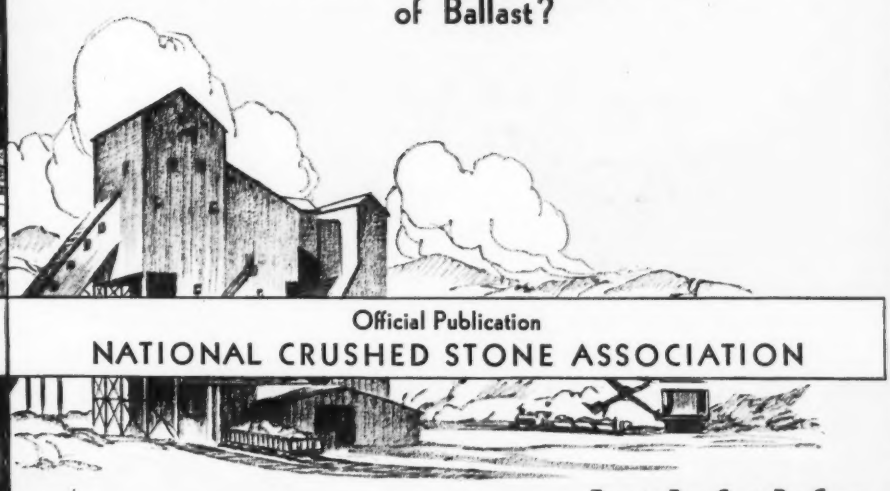

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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

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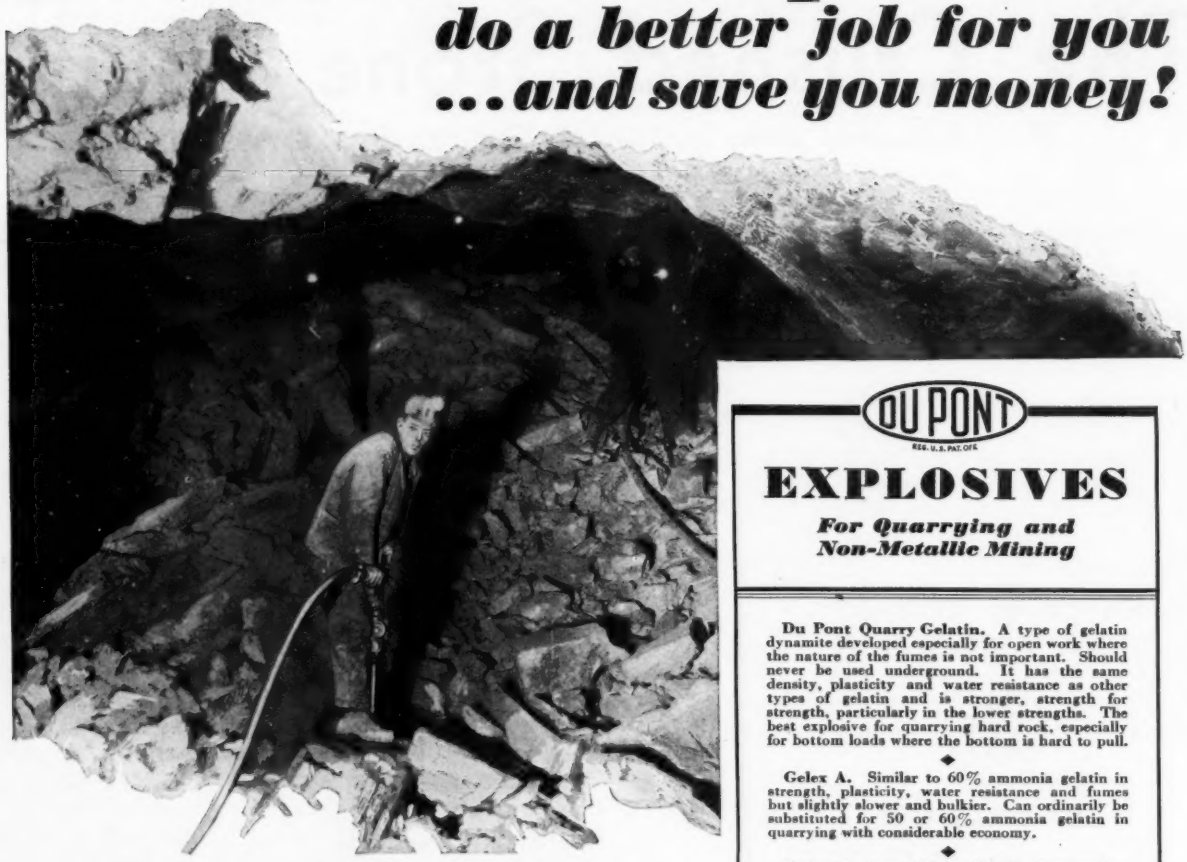

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THE
CRUSHED STONE JOURNAL
WASHINGTON, D. C.
Vol. VII No. 6 JUNE, 1931

More Lessons from Concrete Structures in Service[1]

By RODERICK B. YOUNG
Testing Engineer, Hydro Electric Power Commission of Ontario

◆ Disintegration of concrete structures is receiving more and more serious attention from engineers. To just what extent does disintegration exist and how serious are its effects? The following article describes one of the most complete investigations ever conducted in the field on the behavior of concrete structures. Several hundred inspections have been made and the results of this work should be highly interesting to those concerned with the durability of concrete structures.

ANY public utility, railroad or government has such a considerable investment in concrete structures that their behavior in service is a question about which they must needs be concerned. Realizing this, the Hydro Electric Power Commission decided, some years ago, to systematically study the behavior of their many concrete structures, with a view to learning not only their existing condition, but their probable condition in years to come. The examinations thus made disclosed so many interesting points in connection with the behavior of concrete in service, that it was extended to include other concrete structures in different parts of Canada and the United States, until the number of inspections now made have reached a total of several hundred. This paper is an attempt to set down briefly some of the conclusions that have been reached as a result of these examinations.

Very few concrete structures are entirely free from disintegration of some kind or other, and their defects are usually so much more conspicuous than serious that they lead the casual observer to condemn concrete as a building material, forthwith and forever. Even the critical observer is apt to become despondent by the seeming prevalence of defective concrete, and some of our well-known engineers are still in this mental condition as a result of their examinations.

However, this is not a fair view to take of the behavior of concrete in service. While defective places can be found in most concrete structures, they are usually of very limited extent and of minor importance. After any serious and wide-spread examination of concrete structures, one can hardly come to any other conclusion than that the greater part of the concrete in service today is in good shape and will remain so for many years to come.

One frequently finds old concrete structures in most excellent condition, resisting the destructive forces of nature, as well or better than any other material that could have been used. If anyone doubts the truth of this statement let him visit the Trenton Dam near Rome, N. Y. or the Hinckley Dam nearby, the Lift Locks at Peterborough, Ontario, the Crystal Lake Dam near San Francisco, Calif.[1] or the Thompson[2] and Pine River dams in Northern Minnesota, for these structures offer convincing proof that concrete when properly made is a durable material.

On the other hand, one occasionally meets with a structure in which the greater part of the concrete is disintegrating, but even in these cases it is the rare exception to find one so poorly made that there is not a considerable part of it in first-class shape. Even such a horrible case as that shown in Fig. 3 has its good points, and I think I can safely say, after the examination of a great many concrete structures, that not one per cent can really be classed as failures in the sense that the concrete has deteriorated or will in the near future, deteriorate to such an extent that early replacement will be required.

In any extended examination of deteriorated concrete the observer is struck with the fact that there is a marked similarity in the appearance of many of the

[1] Presented at the 27th Annual Convention, A. C. I., Milwaukee, Feb. 24-26, 1931, as part of the work of Committee 801, Durability of Concrete, see p. 1037. Reprinted from the Journal of the American Concrete Institute, Proceedings, Vol. 27, page 1065.

[1] References are listed at the end of this paper.

affected areas and in the manner of their occurrence. One comes gradually to classifying them by type, and in the majority of cases finds from the evidence of-

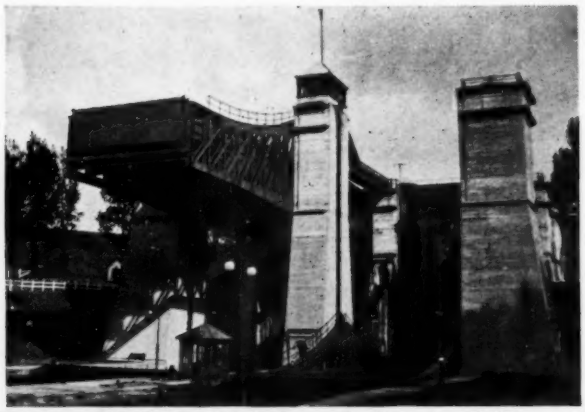

FIGURE 1—Lift Lock at Peterborough, Ontario, 26,000 cu. yd. of almost perfect concrete which has been in service since 1904

fered by the concrete itself, that the circumstances surrounding the cases of a common type are similar.

By far the greater number of cases of deterioration are due to the segregation of the concrete mixture before or during its deposition. The author, in a previous paper[2] before the Institute, gave numerous examples of typical defects due to this cause and explained the manner in which they occurred. Briefly, it was shown there that the principal causes of segregation are the use of over-wet mixtures, improper methods of handling and placing and over-manipulation of the deposited concrete.

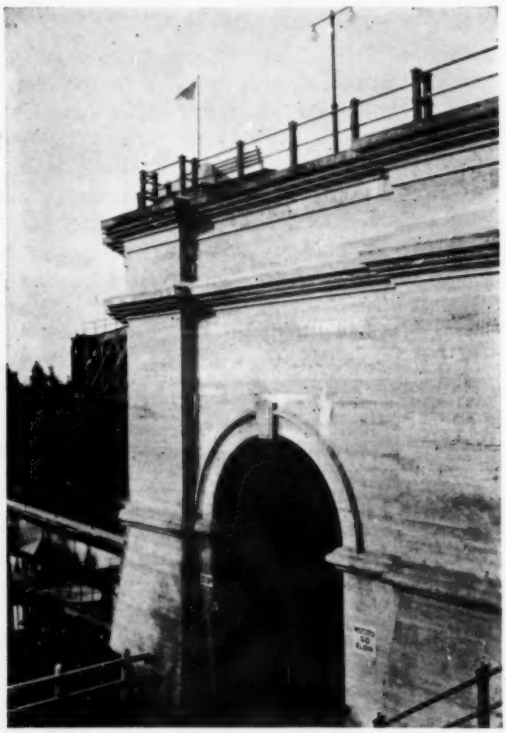

FIGURE 2—Side wall of Peterborough Lift Lock, which is under water pressure. Note almost perfect condition of concrete after 27 years' exposure to severe northern climate

The evils of excess water manifest themselves in water-gain and the formation of laitance at the top of "lifts" and in the accumulation of mortar and fine material in corners, at vertical joints, and under sloping forms. Improper handling and placing cause, not only the familiar honeycombed areas of gross segregation, but the even more dangerous sections of concrete that are not noticeably segregated but are sufficiently so as to be porous and permeable. Over-manipulation is frequently the result of an attempt to obtain good surfaces with poorly proportioned and harsh-working concrete mixtures, by excessive puddling and spading of the surfaces. But whatever the cause of segregation, the result is failure of the affected con-

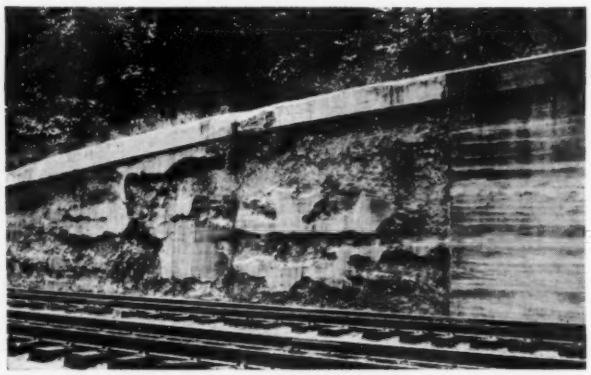

FIGURE 3—Even such a horrible example of poor concrete as this has areas which are in first-class condition. This retaining wall is approximately 20 years old

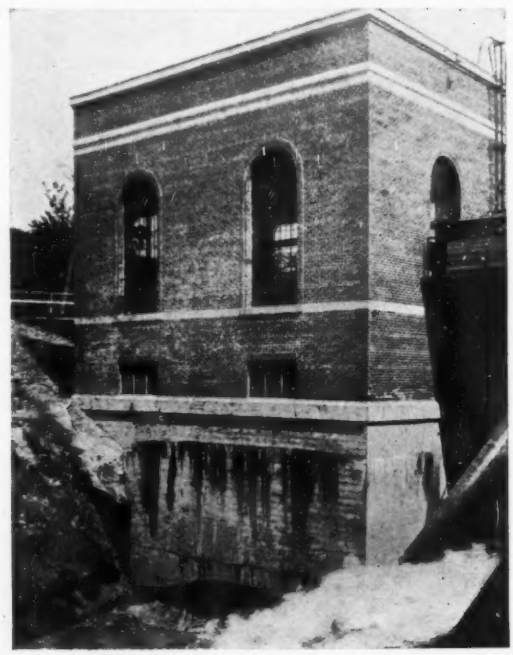

FIGURE 4—Defective horizontal joint caused by careless construction. Corrosion of the concrete adjacent to the joint has necessitated repairs

crete, if the exposure to which it is subsequently subjected is sufficiently severe.

If segregation is also the most common cause of deterioration, it is also the one for which there is the least excuse, and it may be well to point out here, as

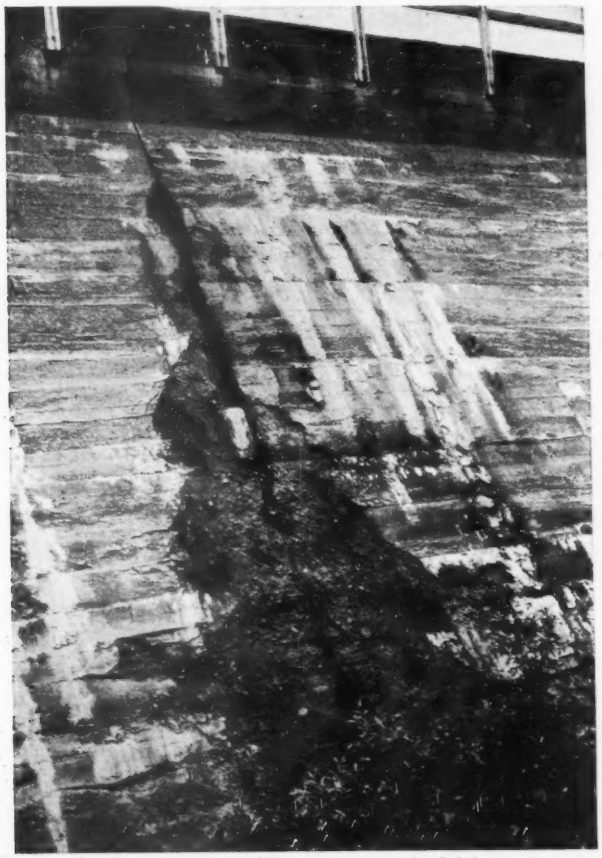

FIGURE 5—Deterioration adjacent to a vertical joint. A porous concrete made from pit-run gravel placed wet

will be done later, that segregation is almost entirely preventable by a little ordinary care and forethought.

After segregation, probably the next most common type of deterioration is caused by joints, either vertical or horizontal, which are not water-tight. With these might also be classed cracks due to shrinkage or structural movements, through which water seeps. Where the concrete adjacent to the joint or crack is of poor quality, due to segregation or other causes, the deterioration may become serious. Where the concrete is good, the effect of the presence of water is likely to cause only an unsightly blemish and so the potential danger of the situation is overlooked. That there is a very real danger in the continued passage of water through concrete is evident if one realizes that practically all its cementitious material is water-soluble and may be removed by solution if enough water is available.[4] The presence of calcium carbonate deposits, sometimes in great quantity, wherever seepage occurs is proof, if other proof is needed, of this statement.

Trouble of this kind is particularly likely to occur in hydraulic structures such as dams and conduits, but is also commonly found in retaining walls and bridges. In the majority of hydraulic structures there is no other corrective except to make the joints water-tight, which can be done by exercising the greatest care in their construction, and by the use of waterstops where, for any reason, movement of the joint may occur. In the case of retaining walls and bridges, much may be done by waterproofing and drainage. Engineers designing reinforced concrete bridges should give a great deal of thought to these points for one finds many very fine structures which would not be in their present unsightly condition if they had been properly drained.

Another very frequent cause of deterioration, especially along the sea coast, is the corrosion of the embedded reinforcing steel. The oxides of iron, which form in the presence of moisture and oxygen from the corrosion of steel, occupy roughly two to three times the space of the original steel they replace, and consequently a reinforcing bar, if allowed to rust, will crack or spall the concrete surrounding it.

This type of deterioration is very prevalent along the sea coasts, although it is by no means confined to those localities. In the southern parts of the continent where frost action is absent, it is by far the most serious form of deterioration and the most common. It is serious because in many cases any considerable

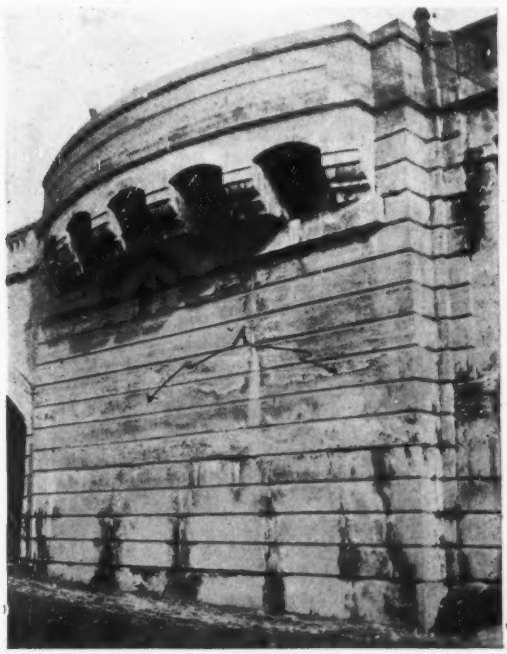

FIGURE 6—Poor drainage necessitated the repair of this bridge pier at "A." Note the deterioration occurring adjacent to lime encrustations

spalling of the concrete endangers the safety of the structure and may even cause its failure.

Since there seems to be no practical method of rust-proofing the reinforcement, the obvious remedy is to embed the bars in dense impermeable concrete to a

depth sufficient to protect them from moisture and air. Seemingly this should not be difficult to do, as one can discover instances where as little as one-half inch of

FIGURE 7—Another example of the deterioration of a bridge pier caused by lack of drainage. Note again the presence of lime encrustations and the patching at "A"

concrete or mortar gave complete protection to the steel. The present excellent condition of most of the concrete ships built during the war is proof of this, and other examples such as that illustrated in Fig. 9 are not uncommon.

However, even if the engineer designs his structure to provide sufficient embedment of the reinforcement and specifies and obtains a dense durable concrete with which to cover it, he has not done his complete duty until he designs his reinforced concrete members in such a way that the quality concrete that he has provided can be placed properly around the reinforcing steel. If the bars are so concentrated and spaced that it is impossible to get concrete around and through them without the use of excess water or over-manipulation, one can hardly blame the concrete or the workmanship for any deterioration that subsequently occurs. In the case illustrated in Fig. 9, a covering of one-half inch of the concrete had protected the steel for six years. The concrete here had the hardness and appearance of one that would test 3500 lb. per sq. in. or better, and apparently had been well cured. However, the beams made of this same concrete repeatedly show cracking along the line of the tension reinforcement, and as far as one could determine, the probable cause was the difficulty of properly placing the concrete in the bottom of the beam below and alongside of the steel.

Certain localities are blessed with very fine aggregates and in these, deterioration of the concrete due to unsound aggregate is practically non-existent. In other localities, not so blessed, cases of deterioration due to the failure of the aggregate are fairly common. The author has had the opportunity to observe concrete structures in several of both types of localities and while there is no question but that the quality of the aggregates has an important influence on the condition of the structures, unsoundness of the aggregate alone is seldom the primary cause of disintegration, although it is usually a contributory factor where other detrimental conditions exist.

This statement is probably more nearly true for the coarse aggregate than for the fine. In most of the cases that the author has examined where the coarse aggregate was unsound, it seemed probable that if the mortar surrounding the coarse aggregate had been of better quality, the unsound aggregate alone would not have been able to cause disintegration of the concrete. It is not at all uncommon to see evidence, such as in Fig. 13, where a great deal of unsound coarse aggregate has been used and still the concrete was generally in good condition. On the other hand, where unsound coarse aggregate is to blame for the disintegration of the concrete, the failure is usually distinctive and complete.

Unsound coarse aggregate may be protected by being surrounded by a durable mortar, but if the mortar itself is made up of unsound fine aggregate, the concrete is doomed. In such cases, the failure is a true disintegration and takes place relatively rapidly, usually manifesting itself within a very few years by a general deterioration and softening of the concrete.

There is a belief, in some quarters, that unsound cement is the cause of most of the deterioration of concrete, while others argue to the contrary. One occasionally meets with a clear-cut case of disintegration where all the evidence points to a cement as the cause, but these cases are rare. The author has made a careful examination of some dozens of deteriorated structures, the condition of which was blamed on the cement, and found therein so much evidence that other factors such as those already discussed, were mainly responsible for the present condition of these structures, that he has been forced to the conclusion, that whereas there may be cements which, although passing all the usual recognized tests, are still unstable in concrete, yet they do not have any important deleterious effect until other improper conditions are permitted to exist. The reasonable conclusion is, there-

FIGURE 8—Only 10 years old, but this bridge has had to be abandoned due to the prevalence of similar conditions

fore, that if a cement meeting the present accepted standard specifications is used in a structure, future deterioration caused by the cement alone is extremely unlikely.

Any discussion of the behavior of concrete in service

is hardly complete without reference to the agencies that bring about its deterioration. It should always be remembered that concrete structures are exposed

FIGURE 9—One-half inch of dense, impermeable concrete has protected this steel for six years

to the same weathering conditions which, through the ages, have levelled whole mountain ranges and totally changed the aspect of continents. It should also be remembered that the same weathering agencies are proving destructive to stone masonry and to brickwork, and that only the complete protection of iron and steel structures save them from being destroyed in a very short time. The following little couplet appearing in the *Engineering News-Record* expresses this thought so aptly as to be worth repeating:

"Bricks will break and rocks will fall,
Paint will peel, and concrete spall,
Wood will rot, and steel will rust,
Ashes to ashes, and dust to dust."

Concrete has many enemies in nature, but by far the most important is the combined action of water and frost. One has only to make a tour from north to south, examining concrete along the way, to discover the part that frost plays in the deterioration of concrete. Below the frost belt, even the poorest concrete will give service for years without appreciable deterioration, and only when used in a reinforced concrete structure where corrosion of the embedded steel causes spalling, will its poor quality become conspicuous. One finds many structures in Florida and along the Gulf of Mexico that are ten or more years old and in first-class condition, which if north of the Ohio River would, in the same period, have required extensive repairs or replacement.

It should be remembered in dealing with the action of frost that it is not the freezing of the concrete itself that is harmful, but the freezing of water that is present in the concrete. Dry concrete, no matter what its quality, is not destroyed by alternate freezing and thawing, but let the pores of that concrete be filled with water to such an extent that no space is available to take care of the expansion that inevitably takes place when water changes to ice, and disruption must occur unless the concrete is strong enough to resist the large stresses set up. If one considers that concrete is relatively weak in tension, one sees the reason why, in making concrete resistant to frost action, impermeability is so much more important than strength.

It should also be remembered that while concrete may resist one freezing or several when saturated with water, yet the continued repetition of this action will in time destroy it. Further, disintegration due to frost proceeds from the surface inward and only a few degrees of frost are required to cause freezing of the contained moisture in the surface layer. It would seem, therefore, that the effects of frost should be more severe in those sections of the continent that have the greatest number of alternate freezings and thawings, and while this is not subject to statistical proof, it seems to be borne out in a general way by observation. It certainly is a fact that as soon as one enters those sections having more than a very few annual frosts, the evidence of frost action is almost as common and as conspicuous as in districts further north, so that it behooves the engineer in those sections having mild winters to remember that his concrete structures are subject to as severe, and possibly more severe exposure than those in more rigorous climates.

If frost is not a destructive agent except in the presence of water, then it might truthfully be said that water is concrete's worst enemy. As already mentioned, water alone will destroy concrete through

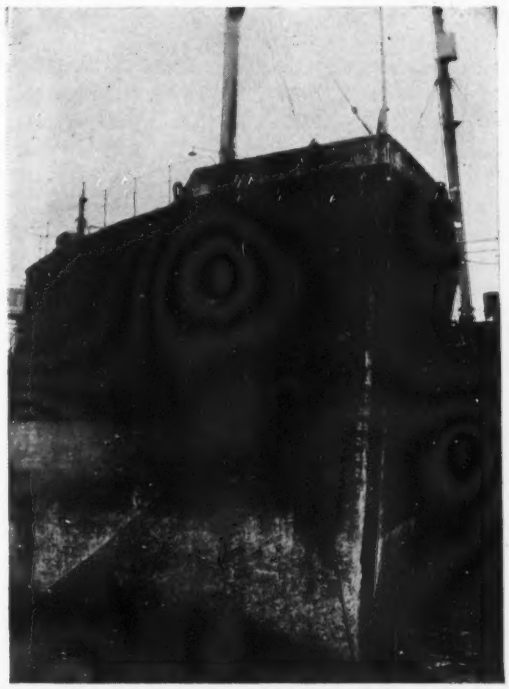

FIGURE 10—Bow of the concrete ship "Faith" built in 1918. No deterioration here

its solvent action, but more important, water is the medium through which most of the other enemies of concrete carry on their attack. Sea water, sulphate-

bearing waters, and bog waters are merely waters carrying impurities that render their destructive action more severe, and all act through the intimate contact

FIGURE 11—Detail of bow of S. S. "Faith." Note freedom from steel corrosion, although some of the reinforcement is only embedded one-half inch

that the water has with the concrete through absorption in its pores.

Perhaps the author is inclined to over-rate the importance of water as a destructive agent due to his long contact with hydraulic structures, but it is also possible that others, differently situated and not having had the same chance to observe the destructive effects of water, under-rate its possibilities instead.

Research tells us that, given the opportunity, any water will, in time, completely remove the binding material which is formed in concrete by the hydration of cement [4, 6, 7,] and a few cases of the kind have been reported in the technical press. [6, 8, 9, 10, 11.] However, for the most part, engineers are inclined to think of such action as a remote possibility, but in this, they are wrong, for it is a quite common occurrence around hydraulic structures, although its true nature is often obscured by being combined with frost action.

Mention has already been made of the solvent action of water adjacent to leaking joints or cracks, but it is by no means confined to these places. Porous concrete, where totally submerged in water, will have the cementitious material dissolved therefrom in a few years, even when the water in contact with it is hard. The author has had three cases of this kind requiring major repairs occur in his work in as many years, besides two others where the solvent action of water was the primary destructive agent, but was assisted by the surface action of frost.

Another manifestation of the solvent action of water is regularly found wherever concrete has been in contact with soft pure waters for any length of time. In such cases, the water dissolves the surface coating of cement mortar, exposing the underlying aggregate. This action takes place relatively rapidly at first, until the aggregate has been exposed, after which the action becomes very slow for then the only cement in contact with the water is that between the aggregates. The author has examined concrete structures less than two years old that have been etched in this way, and others from ten to thirty years old that had a deeper etch, but still no unravelling of the affected surfaces. In hard water this etching action is very slow.

Examples of the solvent action of water may often be found where drainage conditions are such that rain water runs over the surface of concrete. The same phenomenon will be found also on the tops of cornices, handrails, sills, and the treads of steps, and along the lower edges of the same cornices, handrails and sills, where water collects during rains.

None of these surface manifestations of the corrosive action of water are serious, but give a quantity of that same water a chance to penetrate the concrete and the results may be very dangerous.

A study of the characteristics of those waters that have proved most corrosive to concrete, reveals the interesting fact that, whereas the hydration products of cement are soluble in any water, those that are most destructive are relatively pure waters carrying so little CaO in solution that they are lime hungry and having an acid reaction as indicated by a hydrogen-ion concentration below 7.00. These observations have been confirmed by investigations recently reported in Germany.[12]

The addition of certain salts to a water will increase its destructive properties. Sea water and the sulphate-bearing waters of the west are both cases in point, and in both, the salts involved are principally the sulphates of magnesium, sodium and calcium. The action of these compounds on the concrete appears to be both chemical and mechanical, the chemical being partly a corrosive action and partly an interference with the normal processes of hydration, [6, 13] the mechanical due to the disruptive effects of the by-products of the chemical reactions, which forming compounds within the cementing matrix of the concrete require more space than the materials they replace.

A great many natural waters, both ground and river, contain one or all of the sulphate salts in solution, but unless the quantity is considerable, their presence is

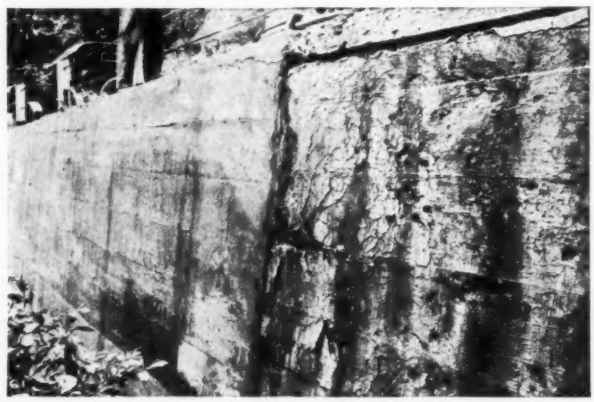

FIGURE 12—Unsound aggregate caused the condition of the concrete at the right. The concrete at the left is similar in all respects, except that a different coarse aggregate was used

unimportant. However, in some parts of both western Canada and the United States, there are localities where the ground waters contain dangerous concentra-

tions of these sulphate salts and where sulphate action becomes a matter of major importance to engineers, but generally speaking, sulphate determination is a

FIGURE 13—Spalling due to unsound coarse aggregate. The effect of the unsound aggregate is confined to the surfaces

local, rather than a continent-wide problem. On the other hand, it is found elsewhere occasionally and the engineer asked to diagnose a case of disintegrated concrete and prescribe for its treatment should not overlook that fact. Its manifestations are usually, but not always, distinctive and may easily be obscured by frost action. Where there is any suspicion of sulphate action, a chemical analysis of the disintegrated concrete will show whether or not one's suspicions are justified.[14]

All sea water structures are liable to sulphate action due to the presence of these salts in the ocean. However, while the author's observations of sea water structures have been limited, they have led him to question whether the destructive tendencies of sea water were due to the salts it contains as much as to the fact that it was water. One can duplicate in the harbors of the Great Lakes all of the types of deterioration that one sees on the North Atlantic seaboard. Along the southern coasts below the range of frost, there is little evidence of chemical deterioration of the concrete, other than the surface etching met with in fresh water where it is of a corrosive type. There is a great deal of spalling due to corrosion of the embedded steel, and while this type of action will naturally be more severe in the presence of salty moist air, it is by no means confined to the seacoast, but is quite common elsewhere. There is the further fact that sea water does not contain high concentrations of the sulphate salts. The author, therefore, is inclined to believe that most of the deterioration of concrete in sea water is due to the same factors which cause it elsewhere and not, as usually claimed, to the presence of sulphates.

We have now considered both the effects brought about by the deterioration of concrete and the principal agencies that have acted to bring these effects into being. We have also considered, though rather briefly, some of the faults of workmanship that usually accompany deterioration. Can we not now deduce from the information thus obtained, what property of the concrete renders it susceptible to attack?

The answer to this is neither difficult nor new; the author pointed it out some years back,[15] and others have done likewise. The fundamental condition which is common to almost every disintegrated concrete is that it is porous in the sense that it is absorptive or permeable to water. Prevent the penetration of water into concrete and at once it becomes a building material highly resistant to all ordinary destructive agencies. Even in the case of those waters which will destroy any concrete in time, such as concentrated sulphate waters, the rate of deterioration is greatly reduced where it is confined entirely to the exposed surfaces, as it must be if the concrete is impermeable.

If one accepts this conclusion, as one almost must after a critical review of the evidence offered by concrete everywhere, then the problem of durable concrete becomes the problem of making it dense and non-porous, or speaking in terms of measureable properties, impermeable and non-absorptive. Reduced to these terms, the problem is theoretically easy of solution for the fundamental factors in the making of a dense, water-tight, high-strength concrete have long been known and are generally well understood. Practically, the problem is more difficult, for the degree of skill and care used in handling and placing concrete is of paramount importance in making it durable, and proper workmanship in these particulars is not always easy to obtain.

No attempt will be made here to consider the factors necessary to produce a dense, impermeable and strong concrete. If the reader is not already familiar with them he has only to consult the recent technical literature [16, 17] to find them discussed in full, but it might be useful for the author to consider briefly here a few points that his observations have led him to believe are important in any concrete which is to be subjected to severe exposures.

FIGURE 14—A porous concrete 20 years old which would have rapidly disintegrated if subjected to frost. Made of finely-graded sea sand and shells

One of the conditions that frequently gives difficulty is the use of harsh, unworkable mixtures. A concrete mixture deficient in mortar is not only more likely to

segregate in handling, but even if this is prevented, it requires a great deal of spading to give presentable surfaces, which, in turn, causes scaling. Mixtures of

FIGURE 15—Another southern wall of very poor concrete, which except for local spalling due to aggregate, is in fair shape

this type are also inherently porous, because their harshness is usually due to a lack of mortar or to a mortar which is itself harsh from a deficiency in the grading of the fine aggregate. In addition to these drawbacks, a harsh mixture is more apt to segregate in handling, and because of its lack of workability, there is much more chance that some well-intentioned individual will attempt to overcome its deficiencies by the addition of water.

Another frequent cause of disintegration is the use of over-lean mixtures. Cement plays a dual role in concrete; in combination with water, it forms the glue that binds the aggregates together, but it and its products of hydration also fill and seal the smaller spaces in the aggregate mass. Any reduction in cement content beyond a certain amount is accompanied by an increase in porosity until a point is reached where, if the exposure is severe, disintegration is almost inevitable.

Instances of disintegration due to lack of cement are by no means uncommon and several have been reported

FIGURE 16—Pockets of segregated concrete from which cement was totally removed by solution. Note position of water line at "A" and slight etching of surface, where water in contact with it is hard. Compare with Figure 18

to the Institute. The matter is one that every engineer would do well to remember when he specifies concrete in terms of its compressive strength. With the modern cements, it is now taking less cement to obtain concrete of a given 28-day compressive strength than it did eight or ten years ago, and the result is that quality as measured by strength is not the same today as then. As an example, take the experience of the Hydro Electric Power Commission of Ontario. In 1920 the Commission built a hydro-electric plant and used approximately seven sacks of cement per cu. yd. to produce a concrete testing 2500 lb. per sq. in. at 28 days. In 1930 they built another plant a few miles away on the same river with aggregate and cement from the same source and using five and three-quarter sacks per cu. yd. obtained concrete testing 3500 lb. per sq. in. at 28 days. Concrete of the same strength as that made in 1920 could have been produced with about four and one-quarter sacks per cu. yd., but the latter, while as strong, would not have been as impermeable, and hence as durable and so in this case the governing feature in the choice of the cement content was durability and not strength.

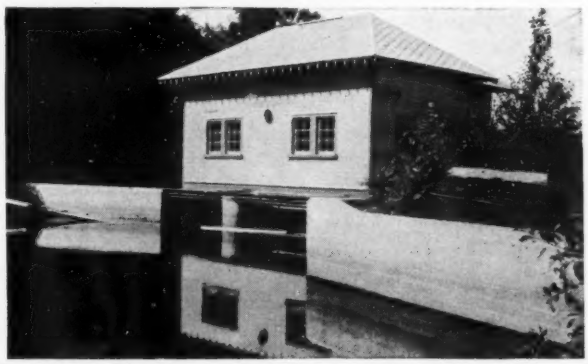

FIGURE 17—The first concrete put in under water-cement ratio control, built in 1919

Strength can never safely be taken as a measure of impermeability in a concrete, for while it is true that for a given set of conditions, the greater the strength of a concrete the less its permeability, it is not true that a certain degree of permeability will exist in all concretes of the same strength regardless of the aggregate, the cement content, or the treatment that it has received. A concrete of today is probably more permeable and hence less durable than concrete of equal strength made ten years ago, and yesterday's standards of quality no longer apply to today's concrete. It is the author's opinion that the wide-spread adoption of the strength specification for concrete is creating a situation dangerous to the industry, for the same engineers who are now adopting the newer forms of specification are still using the old standards of strength as a measure of quality, in the belief that in meeting these they are assured of a durable weather-resistant concrete.

Segregation of every form is extremely dangerous to the permanence of concrete. Some of the conse-

quences of segregation have already been mentioned in the beginning of this paper and the practices which most frequently cause segregation were touched upon. But, whether or not segregation is the result of excess water, improper handling, a poorly designed mixture, or over-manipulation, the fact remains that practically all segregation is easily prevented by the exercise of ordinary care and forethought, and there is no excuse for any architect, engineer or contractor to tolerate its presence in any concrete work for which he is responsible. He has a right to demand and expect good workmanship in these particulars for it costs no more to handle and place concrete without segregation than with, particularly if the effect of segregation on the cost of finishing is taken into account.

Many a concrete job falls short of perfection because of lack of the proper kind of supervision. There has to be on the job some individual with a sound knowledge of concrete armed with the proper authority, whose duty it is to see that the quality of the materials, standards of workmanship, and the after-treatment of the concrete are as they should be. The success of those outstanding cases of durable concrete mentioned in an earlier paragraph was due in no small degree to the fact that such a man was connected with the job. The Peterborough Lift Locks had Walter J. Francis; the Crystal Lake Dam, Herman Schussler; the Thompson Dam, H. C. Ash, and so on, and they are enduring monuments to these men.

Supervision of a concrete job has to be intimate and continuous to be successful. It is not enough to make a daily visit to a job as is the too common practice of many architects and engineers. Someone should be present immediately before and during the placing of any important concrete. Such supervision adds but little to the cost of a structure and is cheap insurance

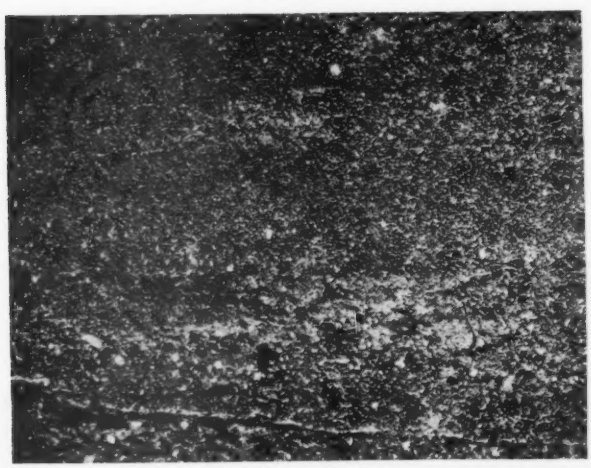

FIGURE 18—Close-up of a part of the concrete shown in Figure 17 which has been etched by being in contact with a corrosive water

to pay for a job that will be free from future trouble. And it is the common experience of those dealing with competent inspectors that in many indirect ways they effect economies of operation that more than offset the cost of their services.

Summing up, the author has arrived at the following

FIGURE 19—Scaling and disintegration due to harsh working concrete mixtures and the conditions arising therefrom

conclusions as a result of his experience with concrete good, bad and indifferent:

(1) Generally speaking, concrete structures are satisfactorily performing the functions for which they were built.

(2) While few concrete structures are wholly free from deterioration, the excellent condition of the greater part of even those which would be classed as examples of poor concrete, and the outstandingly good condition of others 20 or more years old, are proof that concrete is and can be made durable.

(3) Most cases of deterioration can be classified into a few types to which definite causes can be assigned.

(4) Most of the defective concrete is due to faults of workmanship, the use of excess water, and other causes that are strictly preventable by the exercise of reasonable care and supervision during construction.

(5) Faulty construction joints are very prevalent and under certain circumstances may start dangerous deterioration.

(6) Unsound aggregate can cause serious disintegration, but trouble of this kind is not general and usually does not become a factor in destroying concrete unless the concrete is otherwise unsatisfactory.

(7) Cement is seldom a primary cause of concrete deterioration.

(8) The principal naturally occurring destructive agents affecting concrete are frost, water, and the corrosion of embedded steel.

(9) Water, if allowed to penetrate concrete may, and often does, totally destroy it due to its solvent action on the cementitous binder.

(10) Fundamentally, most concrete deterioration is due to its being porous.

(11) The best recipe for durable concrete is to make it so dense and impermeable that water cannot enter.

(*Continued on page 22*)

Nelson S. Greensfelder

Nelson S. Greensfelder

NELSON S. GREENSFELDER has crossed the Great Divide into that land from which no traveler returns. His host of friends and admirers throughout the crushed stone industry will mark his passing with a profound sense of loss and a sincere grief which is the more poignant because of the suddenness with which he was taken.

After a short illness which quickly developed into pneumonia, Mr. Greensfelder died at the Homeopathic Hospital in Wilmington, Delaware, on Sunday morning, April 5. He is survived by his wife, Grace Gleason Greensfelder, and seven-year-old son, Robert J., and by his parents, Judge and Mrs. J. B. Greensfelder of Kirkwood, Mo. The funeral was held from the residence of his parents, the National Crushed Stone Association being represented by E. J. Krause. To his family and business associates we wish to extend our deepest sympathy.

Though we recognize full well the extent of his successes in industries other than our own, we are prone to think of Mr. Greensfelder as belonging to the crushed stone industry. He is inseparably identified with the earlier days of our organization and because of his pioneering work our steps along the road of progress have been measurably quickened.

His service to the crushed stone industry has been outstanding in two fields of endeavor: In the organization of our Manufacturers' Division and in the field of accident prevention. It was in 1924, during the presidency of our late beloved W. Scott Eames, that the idea of organizing our Manufacturers' Division was conceived. Mr. Greensfelder took a prominent and enthusiastic part in organizing this Division and its rapid and continuous growth since the date of its inception is in no small part due to our adherence to the principles and fine ideals which have always characterized that with which Mr. Greensfelder has been associated. The Division has grown from a score of members to close to one hundred. We believe it is particularly true, that to a degree seldom attained there exists between the Manufacturers' Division and the active members of the Association a friendliness and spirit of camaraderie which is a very real tribute to the high idealism of its founders.

It will be clearly recognized by all, however, that Mr. Greensfelder's greatest service to the crushed stone industry lay in the field of accident prevention. Over and above all else he was a humanitarian. His unswerving loyalty to principles of the highest type, his idealism and true conception of the finer things of life, tempered by a quick and keen appreciation of the practical, peculiarly fitted him for work in the field of human relations. His desire to be helpful to humanity found tangible expression in "The National Safety Competition" which he sponsored, inaugurated and devoted himself to up until the time of his death with ardent enthusiasm and untiring efforts. As an instrument for reducing accidents in the mining and quarrying industries, its success has been outstanding.

His monument will be no mute inscription written on a granite shaft for his memory is enshrined in the hearts of the members of the crushed stone industry throughout the width and breadth of this land. In innumerable homes the laughter of children and the happiness of loved ones has been made possible because of his far-sighted, courageous and successful efforts to arouse the crushed stone industry to a sense of its responsibility in the field of accident prevention.

Mr. Greensfelder attended the Colorado College and in 1912 graduated as an Engineer of Mines from the Colorado School of Mines. His service with the Hercules Powder Company dates from November 1, 1918, at which time he was first employed as a salesman and demonstrator. Upon showing marked ability as a writer and advertiser, he was transferred to the headquarters offices in Wilmington and became advertising manager in 1924. At the time of his death he was advertising manager for the Hercules Powder Company and director of *The Explosives Engineer* magazine and also of *The Hercules Mixer*.

He organized the National Industrial Advertisers Association, later becoming President and representing it at the World Advertising Institute in Berlin in 1929. He was also prominently identified with the American Mining Congress, the American Institute of Mining and Metallurgical Engineers, the Institute of Makers of Explosives, the Pine Institute of America and the National Safety Council. In 1929 he was a member of the Harvard Jury of Awards in Advertising. He also served as Chairman of the Industrial Section of the Association of National Advertisers.

In the passing of Mr. Greensfelder the National Crushed Stone Association has lost an ardent and enthusiastic supporter, a loyal and sincere friend. He was a living example of the thought expressed by those immortal words of Pope written some two hundred years ago:

"Teach me to feel another's woe,
To hide the fault I see;
That mercy I to others show,
That mercy show to me."

The seeds he has sown will come to fruition—we will carry on.

Keep Them Interested[1]

By H. W. HEINRICH

Assistant Superintendent, Engineering and Inspection Division, The Travelers Insurance Company, Hartford, Conn.

◆ Every worker has a certain pride in his skill at his chosen occupation. He should be made to realize that skill includes ability to do the job without getting hurt. When safety becomes a matter of pride workers will display a keener interest.

EMPLOYERS and executives require sales ability of a high degree. They may not be called upon to sell the service or product of their industry, but they must "sell" their ideas and convince employees that quantity and quality of performance are expected of them.

One of the foremost objectives of salesmanship is the creation of the desire to buy. In applying this thought to the work of those who are responsible for the control of accident frequency and cost, the objective is the creation of the desire on the part of the employee to be safe and to safeguard others.

Much can be said of competition, bonuses, and prizes; the placing of responsibility; the value of meetings, motion pictures, records, and charts, of publicity, and of the many other ways which will appeal to the employee and encourage him to take an active part in safety work. There are, however, certain less common but highly effective methods.

Most workers take pride in their skill and ability. They are desirous, too, of getting ahead, of succeeding, or at least of retaining their jobs and the good will of their employers.

A Novel Method of Training

There is, today, a general recognition of the direct relation betwen safety and efficient production. It is known, too, that many of the principles of character, that influence personal success likewise, are requirements in safe conduct.

Using these facts as a basis of procedure, a rather novel and decidedly effective method of organizing and conducting safety-educational work can readily be instituted.

The employee can be appealed to, or performance can be asked or demanded of him, not only because greater safety is the goal, but also because the occurrence of accidents and the existence of unsafe practices are positive evidences of his non-success, his inefficiency, and inability to do that for which he is paid.

In proceeding on this basis, the tone of accident prevention activity is radically altered. It is no longer merely a matter of enforcing the company program, but becomes of vital personal interest to the worker. Bear in mind that men are first of all interested in themselves—their own comfort, happiness, security, and success; they are jealous of their privileges and proud of their skill and abilities.

The only well organized safety program so far in general use that employs any of these factors in appealing to the employee is the one which features humanitarian motives.

It has, however, been worn threadbare and consequently often lacks punch and effectiveness. Furthermore, unfortunately (although perhaps quite naturally) many an employee listens to such an appeal with his "tongue in his cheek"; he questions to a certain extent the sincerity and the motives of his company executives who are apparently so solicitous of his safety, and of the comfort, security and happiness of his family.

Happily, nearly everything that is defensible from a humanitarian point of view is also defensible from a practical, economic, and even a normally selfish viewpoint. If, then, it seems of value to seek a stronger and novel appeal to the employee in order to obtain his support in accident prevention, it may be advisable to present the old story from another angle. Such approach can be based upon consideration of the following.

An accident-free record requires skill, experience, ability, good judgment, and mental courage and stamina on the part of the employee; and the attainment of a satisfactory record indicates:

1. That the employee is performing his work as his employer pays him to do it, or, in other words, that he is cooperating with the employer;
2. Efficient work, which results in increased volume and improved quality, and thus directs the attention of the employer to the superior ability of the painstaking worker;
3. Physical and mental alertness;
4. Consideration for the safety and well being of himself and of others;
5. That the employee also possesses foresight, the ability to plan and execute, initiative, concentration, and care.

[1] A paper delivered before the Massachusetts Safety Council, Boston, Mass. Reprinted from *National Safety News* for May, 1931.

Men Have Latent Abilities

It may seem that only a super-man could possess all of these qualifications. However, many a man has latent possibilities which may be brought out by self examination, by the acceptance of responsibility, and by encouragement and advice from his superiors. The effort is worth-while, because the success and advancement of any employee depend almost wholly upon the amount of intelligence and ability that he displays in carrying on his work.

Safety educational programs based on the foregoing factors tend to encourage men in the use of safe practices. Obviously the effect of a program which emphasizes the reverse of the same factors (for example, lack of skill, unsatisfactory performance, and inefficient work) is to discourage *unsafe* practices. Either method may be applicable, according to the type and characteristics of the employees, but as a rule it is better to stress the positive factors.

In practice such procedure, while founded on humanitarian and economic motives, influences the employee almost wholly because of its appeal to his own personal interests.. Safety becomes a matter of pride. He avoids unsafe practices because he wants to, rather than because of the insistence or pleadings of some other person. Accident occurrence is properly pictured as bungling and fumbling, as stupidity and lack of skill, and becomes something to be ashamed of and to be avoided.

How can these things be worked into a safety program?

Education is Not a Cure-all

First of all, it is well recognized that safety educational programs cannot be expected to prevent the majority of accidents which occur because of unguarded or ineffectively guarded machines and mechanical hazards, or in connection with inherently dangerous processes. All accident prevention work must therefore begin with dangerous physical or mechanical conditions and must include continuous corrective procedure. There is, of course, much room for progress in preventing mechanical accidents but the field for educational effort in eliminating man-failure accidents is vastly greater and more profitable. It is toward this group of accidents that educational programs are directed, and it is here that the method of appeal, described in this article, is most effective.

Second: The unsafe practices chiefly at fault should be found, and the reasons for their existence (the causes of the accidents) should be ascertained.

Third: Subsequent activity, in the form of meetings, talks, letters, discussion, admonition, interviews, and supervision, should be based on one or more of the items listed as "qualities of a safe worker."

An example may serve to illustrate the proposed method of attacking two major unsafe practices, employed by a "Committee on Personnel Improvement" in a certain manufacturing plant where there had been many tripping and falling accidents.

At a meeting of the committee, the secretary introduced the chief topic on the agenda by reading the following letter from the general superintendent of the company:

> To the Members of the Committee on Personnel Improvement:
>
> Gentlemen: — Two improper conditions have been brought to my attention, which your committee is authorized to deal with. One relates to the plant as a whole; the other to a single department.
>
> First—Trays and boxes are provided for receiving parts that have been machined. The machine operators throw the parts on the floor about the bases of machines, and depend on the helpers to pick them up and stack them in the receptacles. Our records show that this practice results in many tripping and falling accidents, and that it is a direct violation of long-standing instructions.
>
> Second—The men in the assembly department are frequently injured while using wrenches. Investigation shows that in most cases they do not set the wrenches squarely on the bolt heads or nuts, and the reason or cause is given as lack of skill and good judgment.

The conclusions of the committee were as follows:

1. Disregard of instruction to use boxes and trays reflects adversely upon the ability and loyalty of the workers and the supervisor. If the boxes were arranged conveniently (as they should be) the machine operator would actually save time by using them. Often the parts get under his feet and he is obliged to stop his regular work and move them aside. Sometimes parts roll under the machines and in several cases they have become wedged under foot treadles. More helpers are required to pick up and stack parts than should be necessary. Duplication of effort, some spoilage, and inefficiency and waste in general are indicated. The machine operators are paid to handle their work in the proper way, and the supervisor is paid to see that they do so.

Action taken. Each department head was directed to see that:

(a) Parts be immediately picked up and stacked in boxes and trays;

(b) Instruction relating to this matter be re-issued;

(c) Instruction be more rigidly enforced;

(d) One skilled operator in each depart-

ment be detailed to demonstrate the greater speed and efficiency obtainable by use of proper method, as compared with the present improper method;

(e) Notices be posted referring to the lack of skill and ability shown by operators who fail to use boxes;

(f) Investigator be assigned to check conditions daily, for one week;

(g) Within one week each department head be required to report progress in educating workers, to the Personnel Improvement Committee.

2. The injuries from slipping wrenches in the assembly department are direct evidence of careless and unskilful work, and of inadequate supervision. An experienced and skilful machine assembler will rarely place a wrench on a nut or bolt head in such an insecure manner that it will slip off. Wrenches are kept in good repair, nuts and bolts are squarely faced, and wrenches of proper size are used. Although the assemblers are not inherently unskilful, it is evident that they do not apply their skill and experience to the work at hand. There is an unnecessary loss of time as the result of numerous visits to the first-aid room for treatment of avoidable injuries, and because of lost motion and delays.

Action taken. Instructions were issued to the effect that:

(a) Within one week the department head must hold a special meeting of not more than ten minutes' duration, at which he should call the attention of all assemblers to the careless method of handling wrenches, and state that satisfactory performance must be forthcoming;

(b) Records of accident-free men of long service be posted, and that special reference be made to skilful performance;

(c) Accident-repeaters be instructed in the safe use of wrenches;

(d) The employees be asked to submit suggestions to improve present conditions;

(e) A job analysis be made of assembly work, to see if methods can be improved through engineering revision;

(f) The department head be admonished to exercise more continuous and keener vigilance in observing careless handling of wrenches, and make a report of progress to the Personnel Improvement Committee, within one month—this report to be checked with the accident frequency and be considered by the committee.

Stress Skill and Performance

Observe that safety, *per se*, is not featured in the title of the committee and in its conclusions, nor in the statements of the general superintendent. The entire problem is treated as one that reflects upon skill and performance, notwithstanding that it arises primarily because of injuries to workmen.

Another striking variation in this safety organization work is the specific nature of the problems discussed. Only two types of accidents were selected, and these were at once resolved into definitely stated unsafe practices, together with the reasons or causes for their existence. No time was wasted in safety generalities.

The pride of the employee was appealed to, and the ability of the supervisors to handle men was emphasized.

The results of this method of attacking accident occurrence were highly satisfactory. Of the many interesting sidelights which were developed, two are given as examples. By featuring mechanical skill and engineering revision in lieu of safety for humanity's sake, the employees and their foremen were encouraged to devise better, safer, and more efficient methods of conducting operations of a long standardized nature.

The suggestion was made and adopted that trays and boxes be partitioned or cleated so that machined parts could be more quickly and conveniently stacked. It was also suggested that a bench or stand be placed adjacent to each machine, at the same height as the truck platforms, so that the trays and boxes would necessarily be placed in the most convenient position for the operator, and so that they could be transferred to the trucks without lifting them off the floor. With regard to certain parts that were to be dipped, pickled, or washed, subsequent to machining operations, the suggestion was made and accepted that strong wire-basket trays suitable for holding the parts in the caustic or acid bath be used by the machine operators.

The pressure brought to bear on process and procedure revision in the assembly department, and on the necessity for greater skill in carrying on the work, resulted in the adoption of power tools. These were portable motor-driven drilling machines to which socket wrenches with friction disks were fitted. It was also found that nut and bolt sizes could be standardized and reduced in number, with the result that less time was spent in changing and adjusting wrenches.

The long-service accident-free men whose names were given in the posted notices referring to skilful performance were enthused by this recognition of their efforts, and some good-natured banter was indulged in, with the result that the slack performers became more proficient and careful.

(*Continued on page 24*)

What Factors Control the Service Value of Ballast?[1]

By J. V. NEUBERT
Chief Engineer, Maintenance of Way, New York Central Railroad, New York City

◆ The production of railway ballast constitutes a substantial proportion of the tonnage of many crushed stone producers. To them Mr. Neubert's discussion should prove particularly interesting.

WHAT might be called the useful or service life of railroad ballast, meaning rock or crushed hard slag, depends on:

(1) It must be hard enough to resist the crushing effect of the wheel loads which pass over the track.

(2) It must be hard enough to resist the action of the tamping tools upon it.

(3) It must be of such composition that it will not disintegrate due to weathering conditions.

Soft ballast disintegrates rapidly and its deterioration is very pronounced when subjected to the shock of the wheel loads and tamping tools.

Moreover, soft ballast absorbs the moisture resulting from frost and other climatic conditions, which collects and holds the fine materials produced in manufacture, or those foreign materials which result from railroad service. This causes the ballast to become sluggish, retards drainage and develops very rapidly a poor maintenance condition, to overcome which, of course, means added expense.

To fulfill the conditions that the desirable ballast should have, we should know:

1. Specific gravity and weight.
2. Toughness.
3. Absorption percentage.
4. Wear and cementing value.

The size is an important factor. The minimum should be ¾ in. to 1 in., the maximum 2½ in. to 3 in. However, ballast that will pass through a 2¾ inch ring or lay on a ¾ inch ring, will be found to meet the general service conditions. The reason for these limiting sizes is that it gives a ballast that is easily worked, affords a good support for the track loading, and produces that slightly resilient or cushion effect so necessary for smooth and comfortable riding conditions.

Ballast should be as clean as possible, free from screening dust or other foreign material, because to give good service it must afford ample drainage from the start; some railroad officials are advocating, in order to bring about such a condition, the advisability of washing the ballast prior to its application.

If the ballast is not clean when first applied, the foreign material which collects through service, from equipment, storms and the like, adheres to it more readily and thus makes it more difficult to clean. This is particularly important with the changes in service of the steam locomotives, making for longer runs, and the introduction of automatic stokers using pulverized coal, resulting in more dust and more and finer cinders deposited on the roadbed than heretofore.

With cleaner ballast, the unloading from cars and the work of ballasting can be better regulated. Mechanical means are being devised and improvements made from time to time for the economical and proper unloading and distribution of ballast not only in the desired quantities but also at the required locations. It is very important, therefore, that the producers furnish the cleanest ballast possible and of a size strictly in accord with the specifications.

The majority of the plants today, particularly the more modern ones, have improved ballast conditions materially by putting in vibrating screens or other means to overcome this condition. There are some, however, who I feel are not giving it the necessary thought or consideration they should.

Approximately ten years ago, the question of cleaning stone or similar ballast in track periodically by setting up a definite schedule, was not considered. It was done to some extent as the general maintenance program progressed, but with the improved conditions I have cited, it has changed considerably and where ballast was cleaned by hand heretofore once in six or more years, depending on service conditions, it is now being done by machinery on an average of from two to four years, or at least one-third more frequently than in the past. This prolongs the life of the ballast, as well as protecting and maintaining its drainage qualities. One can readily see, therefore, it must be of such size and quality that it can be cleaned and used again as track ballast.

I would suggest as a boiled-down specification, the following:

Stone should be made from hard, tough, durable trap, flint, or limestone rock or other stone acceptable to the chief engineer of the railroad company—crushed to such a size that it will pass through a

[1] Presented at the Fourteenth Annual Convention of the National Crushed Stone Association held at the Hotel Jefferson, St. Louis, Mo., January 19-22, 1931.

two and three-fourths (2¾) in. ring in any direction and shall be screened in two and three-fourths (2¾) in. revolving screen and shall be free from all dust, rubbish and dirt, no stone to be less than one (1) inch in diameter. Each car shall contain stone ranging in fair uniformity between these limits.

The question has been asked a number of times: What is the service life of stone ballast? I can find no records, nor have I any knowledge of any cases where the ballast section has been used to destruction. In fact, it does not seem to me to be possible that ballast, of such kind as we are speaking, can be entirely destroyed under our operating conditions.

Tests have been made to determine service life but were abandoned as being of no particular value.

Stone or similar ballast has been used on our lines for approximately thirty years. During this period some additional ballast has been applied but largely in connection with a surfacing program. This additional stone was used in part, to restore the consolidation of material and also to increase the cross-section, and in some cases, there may have been some loss in the sub-grade.

The original stone, with the exception of some small deterioration due to service conditions, is as good now as when installed. Some cleaning in the top course was found desirable, which program has now been started. The loss resulting from cleaning, together with the slight deterioration, and the shrinkage due to the consolidation of material under traffic, must be replaced, and in my opinion, is often erroneously taken as an indication of service life.

The replacement of ballast for the reason just stated varies considerably, depending upon service conditions. The best estimate I have been able to make would be from 2½ to 3½ per cent annually, but would be classified as a replacement due to loss rather than an indication of service life.

The question has been raised many times as to why railroads should not manufacture their own materials. I, myself, feel that a railroad has only to sell transportation service, and they should do that as economically and efficiently as possible.

The earning power of a railroad and its resultant income depends largely upon and is forecast by the prosperity of the community it serves.

I feel sure that if materials are made and fabricated according to recognized plans and specifications, and purchased from outside industries, they can be produced on a more rigid inspection basis, and be built and followed more closely than if such commodities were made by themselves.

The simplification of plans, standards and methods which various engineering societies and associations have made and adopted, has aided this materially.

In line with this, I feel that the railroads should maintain such maintenance force for their upkeep as their earnings permit, with the proper material and tools required, and they should keep in repair such materials which have possible further service or life, when by doing so they can get a fair and economical return.

One says knowledge comes from the outside. Understanding comes from within.

I think within your National Crushed Stone Association you have contributed a great deal in the service, application and use, and of course, in the manufacture of ballast, and I think of the story of a colored fellow who was born down in Mobile, who from his days of toil had $500 in the bank. He moved to St. Louis and thought he would transfer that $500 from Mobile to St. Louis. He went to the bank in St. Louis and asked if he could transfer the account.

The man said, "Yes. Where it is?"

He told him it was in a colored bank in Mobile, so the banker told him, "All you have to do is to give me your name and address, make out a check, and we will transfer the account."

A few days later the check came back, marked, "No Funds." The colored man was called to the bank, and they told him the circumstances. He said, "That is funny. I worked a number of years and saved my money. I never spent very much. I didn't have to buy any clothes. I thought I had the money there. I put it in the bank."

Finally he convinced the auditor of the bank that it was there. He wrote back, and finally the bank answered him and said, "We did not mean to say that Sam Jones had not $500 in our bank, when we marked the check 'No Funds'; we meant the bank had no funds." (Laughter)

My friends, what I am bringing out now, and I sincerely mean it, is that the National Crushed Stone Association has the scientific and the field forces and the knowledge that you collect from the individual bank accounts or funds to carry on your work, in the proper way, whether it is highway, railroad, or whatever it may be. It is only a question of having a little time and patience whereby the resources of the big banks or the industries will come about and we get back to normal conditions.

RAG MERCHANT—Any beer bottles, lady?

LADY—Do I look as if I drank beer?

RAG MERCHANT—Well, vinegar bottles, lady?

Staley Journal.

SERVANT (announcing new arrival at the party)—"Mr. Tootle."

MR. TOOTLE (in undertone)—"And Mrs. Tootle."

SERVANT—"And Mrs. Tootle, too."—*Bury Post.*

« « EDITORIAL » »

Five Thousand Dollars

FIVE thousand dollars! What could your firm do with Five Thousand Dollars? In one minute you can think of more than a dozen ways to use it to great advantage. Now if you could cut the cost of stone in your plant two cents a ton, and if your average production is 250,000 tons a year, there is your Five Thousand Dollars. If your production were half a million tons a year, a saving of only one cent per ton will of course produce the same substantial saving.

You have already kept abreast of the times in your equipment and your methods, you believe. You are confident that there is no serious waste of time or materials in your operating, but do you really *know?*

The only possible way to obtain a complete analysis of all the factors which go to make up your actual cost per ton for stone produced is a good cost accounting system. With such a system, you can make monthly and yearly comparisons in your own business with your own previous records, and discern more clearly where further economies are possible.

Furthermore, if a uniform cost system on the same general plan is being used by different concerns, in the same line of business, some interchange of the results obtained can be helpful to all in reducing costs. For instance, you may be able to study the cost analysis of another quarry whose annual production in tonnage is not greatly different from your own (but without your knowing what individual quarry it is or where it is located) ; and you may notice some specific item such as "Haulage" or "Primary Blasting", which is considerably lower than your own figures per ton for that same item; whereas in regard to certain other items, you may be about the same as the other quarry or may yourself be lower. You can then focus your attention on that item in your own operating which appears comparatively high and endeavor to reduce it. The information you have used to check against your own figures has helped you to learn where to try to reduce.

In any manufacturing concern, as we all know, the manufacturing overhead (as distinguished from general overhead such as selling expense and administrative expense) is vitally important. Whether a plant is idle for any part of the year matters enormously in the cost of manufacturing; and nearly all quarry concerns in this country have to do a seasonal business, closing down in the Winter. The rising cost of manufacturing overhead in recent years has become a serious problem. A good cost accounting system will help us to understand better our own peculiar problems in this branch of our operating expense.

The Uniform Cost Accounting Committee of the National Crushed Stone Association has prepared a cost accounting manual which will soon be issued. We believe that the system, as laid out in the manual, will be a great help to any quarry operators who adopt it. Other more highly technical industries than our own have already learned that one indispensable tool in effective operating under the competitive conditions of to-day, which are likely to become increasingly so in the future, is a good uniform cost accounting system.

Don't Be a "Lone Wolf"

"THE proper description of a 'lone wolf' ", says Howard H. Edmonds, writing in *The Cleveland Constructor,* "is one who prefers to hunt alone rather than run with the pack." "The solitude of the forest", continues Mr. Edmonds, "is music to his soul, and the result of his kill is his own. He adds nothing to the welfare of the herd but, in times of hunger is quick to take advantage of the pack's forays—even to filching the kill, if it can be done without danger to himself.

"History is filled with accounts of those who sought to play a lone part in the world of things. There are, to be sure, some outstanding examples of great achievements as the result of individual effort. However, you never heard of a single man building a 'Brooklyn Bridge,' a 'Woolworth Building,' or impressing Congress with his logic unless he had an organization back of him.

"The trend of human relations in the last two hundred years has been toward collective effort for the benefit of the whole. This is a fundamental principle of our present day civilization, applying alike to governmental functions, social and religious life.

"The 'lone wolf' however, still has his counterpart in all these circles. He is the man who stays out of things; he is the man who demands protection from the forces of law and order, good roads on which to run his automobile, schools for the education of his children, institutions to house his mentally unfit, and then he feels he should not pay his just share of assessments and taxes.

"He is also the man who refuses to lend his time and money to the organized efforts of his associates to better conditions in their trade circles. He stays out and still reaps the benefits while others sow the seed. The peculiar process of reasoning that results in a man setting himself apart from his fellow businessmen is first of all actuated by a selfish desire to hunt alone. He believes that by so doing he has freedom of action that he could not have otherwise and, by not joining

his trade organization he need not be bound to rules, regulations, ethics and practices which, in his mind, restrict him in getting business.

"He is also fearful of contact with his competitors, especially his larger competitors. He feels that these competitors want to bind to these rules and practices, and at the same time reserve for themselves the right to break when advantageous to do so.

"He further believes that his larger competitors run the trade organizations for their own benefit alone, and that nothing is done for the benefit of the smaller operator. He can conjure up many other reasons for staying aloof, all of which support his conviction that he is better off out than in. If he is frankly questioned as to why he will not join his trade organization he falls back on the time-worn answer that he 'cannot afford to do so.'

"The easiest of all of these objections to combat is the 'cannot afford' idea. No man or firm ever went into receivership because of the dues paid into a trade organization. On the contrary there are many records of organizations which have saved members from bankruptcy and, because of the exchange of ideas, studies of better business and manufacturing methods, and frank discussions of common problems, many have been turned from failure to certain success.

"No organization or society can long exist unless it performs a service. No organization that benefits only a few can last, and the proof of their worth is found in the growth of hundreds of trade bodies that are daily rendering services in practically every line of endeavor. One has only to look at what has been done in the steel and iron industry to recognize the value of organization. That industry has stabilized prices, regulated production and, in cooperation with governmental bureaus and railroads, has equalized freight rates so that the small and long distance producer finds little or no discrimination.

"The California Fruit Growers by organization lifted their industry from ruin to prosperity. 'Say it with flowers' is a household doctrine. The paint industry says, 'Save the surface and you save all'; and paint manufacturers reap the benefits. Bankers, building and loan companies and retail stores all unite to improve their conditions. They know what they want—and get it. All of this is the result of organization, so why should it not be so in the building industry?

"The man who is afraid of organizations should remember that no one man is powerful enough to run a trade body for his benefit alone. No man should be afraid of contact with his competitors, big or little. Their problems are the same as yours and knowing them often changes your viewpoint. Your competitor may be a splendid fellow if you will but meet him on a common ground.

"Being a 'lone wolf' is selfish and out-of-date—a relic of times when every man was a law unto himself. Your trade organization needs you—it needs your ideas, your counsel and support. If you do not like the way things are run, get into action and say so. If you feel that your competitor is not ethical in his practices, be sure of your ground before you condemn him. In any case you don't help matters by remaining aloof. The world is so constituted that none of us are independent of the other no matter what we think of it."

Mr. Edmonds was directing his remarks primarily to the construction industry, but what he has said applies no less pertinently to the crushed stone industry. Unfortunately there are still a number of crushed stone producers who apparently fail to recognize that they have a responsibility to the industry of which they are a component part. Excellent progress has been made during the last few years in organizing the crushed stone industry, but even better progress can be made in the years to come if a fuller measure of cooperation is extended by those who have so far not seen fit to identify themselves with the National Crushed Stone Association. The age of the "lone wolf" in American business has passed; progress is made only through organized effort and to those crushed stone producers who are not members of their national organization we herewith extend a most cordial invitation to join.

More Lessons from Concrete Structures in Service

(*Continued from page* 13)

(12) Harsh, unworkable concretes are prone to deteriorate.

(13) Lean concretes, no matter how strong, are not durable.

(14) Intelligent and constant supervision of concrete during construction is necessary to insure durable concrete.

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« « WITH THE LOCAL ASSOCIATIONS » »

Texas Producers Conduct Interesting Experiment

THE Texas Crushed Stone, Sand and Gravel Association, in cooperation with the Division of Materials and Tests of the Texas State Highway Department, recently conducted an experiment which we believe to be unique in the experience of material producers. It was felt by W. W. Carson, Jr., Executive Engineer of the Association, that if the plant superintendents of the various member companies could become better acquainted with the methods used in making the laboratory tests on concrete aggregate and other material that it would be a distinct advantage, not only to the plant superintendents personally but also to the companies which they represented and to the Association as a whole. Through such a contact it was believed that a much better understanding would develop which would result in closer and more effective cooperation between the State Highway Department and the producers of the State.

It was therefore decided to hold a school for material plant superintendents and Mr. W. H. Wood, Engineer of Materials and Tests of the State Highway Department, accordingly invited the superintendents of the various plants producing aggregates used on state highway work to be present at a two-day meeting held at the Testing Laboratory of the State Highway Department. The attendance at this meeting was even larger than expected and those who attended found the meeting to be particularly interesting and instructive.

Such a plan would seem to have such obvious advantages that it might well be emulated by the producers located in other territories. Lack of space makes it necessary for us to omit publication of the program for the school, but we know that Mr. Carson, whose address is 601 Littlefield Building, Austin, Texas, would be more than glad to forward a copy to any who might be interested in working out something along the same lines.

New York Producers Discuss Many Problems

AS the construction season gets under way the crushed stone producers of New York State find many problems demanding their attention. Two meetings of the New York State Crushed Stone Association were held during May, one on the first of the month at Syracuse and the other on the twenty-second at Utica. A. S. Owens, president of the organization, presided at both meetings.

The following matters which were discussed at the first meeting should be of general interest.

Mr. John Rice, Jr., chairman of the Committee to Investigate a Standard Form of Sales Contract, presented a comprehensive report of the committee's investigations and expressed the hope that the Association would recognize the value of adopting some type of standard sales contract. The suggestion appealed to the members present, for the Association recorded its approval of the proposed sales contract form and recommended its use by all producers. A substantial number of the firms represented at the meeting agreed to use the standard sales contract form.

The meeting considered itself fortunate in having as its guest, A. L. Worthen, president of the National Crushed Stone Association. Mr. Worthen briefly outlined some of the more important activities of the National Association with particular reference to the necessity for increasing the scope of the Association's research work.

President Owens spoke of the new stone sizes for 1931 and called attention to the necessity for proper interpretation to conform with specifications. After discussion it was decided to place this matter in the hands of a committee appointed by President Owens and consisting of F. C. Owens, A. J. Hooker and B. R. Babcock.

At the meeting held on May 22 at the Yahnundasis Golf Club at Utica, the morning was devoted to recreation. In opening the business meeting in the afternoon Mr. Schaefer stated that President Owens had appointed Mr. Babcock, Mr. Caldwell and himself to act as a committee to meet with a similar committee of the Empire State Sand and Gravel Association to discuss all matters of common interest.

The question of uniform sales contracts was again placed on the floor and it developed that a majority were in favor of using the approved form. The Secretary was instructed to procure three thousand copies and pro-rate them among the member companies in accordance with their normal production tonnage.

It was suggested that whenever members might encounter difficulty in connection with the interpretation of specifications that they immediately communicate with the Interpretation Committee which was appointed at the preceding meeting.

A letter from Secretary Hayes of the Contractors Association was read to the meeting in which it was suggested that a council of groups identified with the construction industry be formed. It was pointed out that problems frequently arise which relate both to the industry and to the particular group and that

periodic discussions of such problems by the proposed council would be helpful to all. The meeting was favorable to the creation of such a council and the Chair was authorized to appoint a committee to represent the crushed stone industry on the council. President Owens designated the same committee which had previously been appointed to consider matters of mutual interest with the Empire State Sand and Gravel Association, consisting of Messrs. Schaefer, Babcock and Caldwell.

A most interesting and important discussion then developed regarding the apparent non-uniformity of conditions throughout the State. It was pointed out that the interpretation of sizes is by no means consistent, that different sizes of stone are used in different localities for the same type of work and that there is a difference in application of the thirty-day credit basis of freight charges previously agreed upon. It became clearly evident that it would be to the mutual advantage of all concerned if uniform, standard methods of procedure could be developed. It was decided to hold a special meeting of the Association to consider this problem at Syracuse on Monday, June 8, and the Secretary was requested to confer with all firms in the Association, urging that they each have a representative present. It was decided to hold the regular June meeting of the Association at Syracuse on the twenty-sixth.

Keep Them Interested

(*Continued from page* 18)

Apparently the featuring of lack of skill and good judgment, in lieu of accidents and hazards, is defensible from a psychological point of view. There are some men who scoff at the mention of danger, who are ashamed to make much of injury, and who even go so far as to refuse first aid because they think it is needed only by weaklings. The mental processes of such men are more readily stirred to common sense action when accident ocurrence is treated as a reflection on ability and skill.

Fundamental truths support the idea of carrying on accident prevention work in the manner here described. Accidents are, in fact, errors. They violate the principles of nature and likewise of economy. They are concrete and specific evidence that something or somebody has failed. Therefore, the employer, executive, or safety engineer who may be seeking a new approach to an old problem would do well to consider a program based on the knowledge that no skilled workman relishes a reflection on his ability to do as good a job as his fellow worker.

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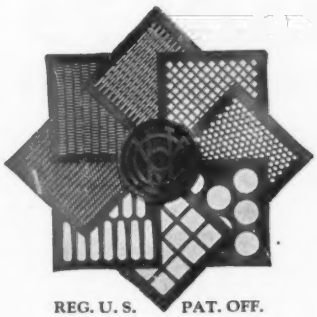

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The quality of CROSS Screens gives longer service, increased production and lower cost.

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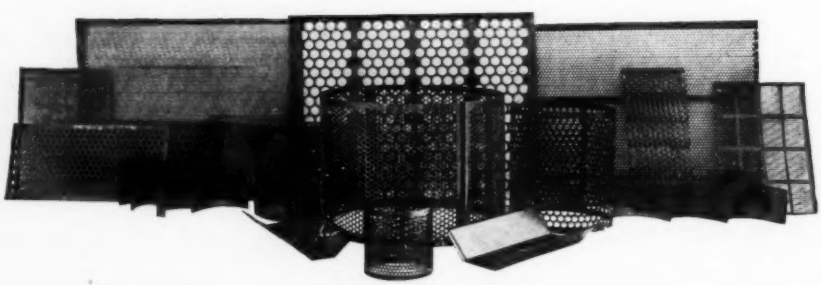
BUCKETS, TROUGH, FLIGHTS, CHUTES, ETC.



Rush Orders often Shipped within twenty-four hours

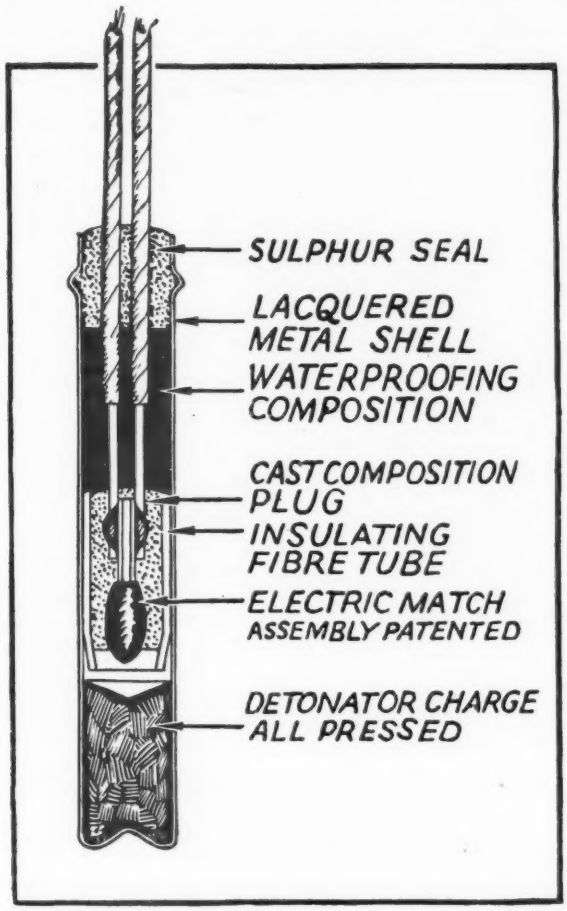
CROSS ENGINEERING CO.

CARBONDALE, PA.

UNIFORM FIRING *is a feature of*

ATLAS

ELECTRIC BLASTING CAPS



LAG IN FIRING of *so-called* instantaneous Electric Blasting Caps connected in series or in parallel means loss in efficiency of explosives.

Field tests have proved that Atlas Electric Blasting Caps are extremely uniform and the lag in firing is negligible. This uniformity is secured thru the intimate contact of the igniting compound with the bridge wire in the Match Head Primer. This igniting compound ignites and flashes uniformly; . . . not at times deflagrating and at others detonating . . . to cause lag in firing.

Quarry charges—well drill charges, piston drill charges and snake hole charges, should fire so as to be mutually beneficial; wedge cut blasting in underground mining most essentially demands uniform firing of all charges!!

The uniformity in firing of Atlas Electric Blasting Caps can be demonstrated to your complete satisfaction. Write nearest branch.

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EXPLOSIVES
ATLAS POWDER COMPANY

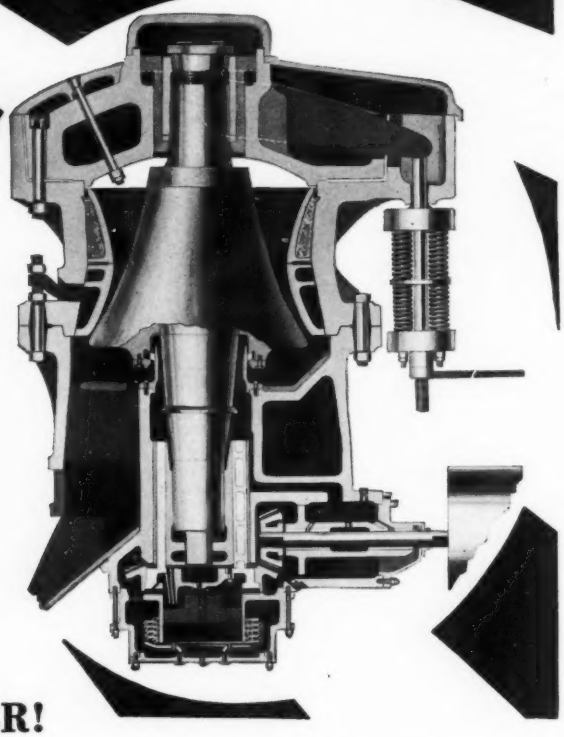
A proper explosive for every blasting requirement

WILMINGTON, DELAWARE

Branch Offices: Allentown, Pa.; Boston, Mass.; Houghton, Mich.; Joplin, Mo.; Kansas City, Mo.; Knoxville, Tenn.; Memphis, Tenn.; New Orleans, La.; New York City, N. Y.; Norristown, Pa.; Philadelphia, Pa.; Pittsburg, Kans.; Pittsburgh, Pa.; Pottsville, Pa.; St. Louis, Mo.; Wilkes-Barre, Pa.

a master stroke!

the T-Z reduction crusher



NOT JUST ANOTHER CRUSHER!

BUT

1. A BREAKER OF GREATER CAPACITY AT SMALLER THAN USUAL SETTING.
2. MAKES LESS OVERSIZE THAN OTHERS.
3. HAS LARGER RECEIVING OPENING AND GREATER RATIO OF REDUCTION.
4. HAS NO CHOKING POINT.
5. HAS ADJUSTMENT RANGE OF FIFTY PER CENT.
6. ADJUSTABLE DURING OPERATION.
7. MADE IN SIX SIZES TO MEET ALL REQUIREMENTS.

CONVERT YOUR OLD CRUSHER INTO AN UP-TO-DATE REDUCTION MACHINE

TYPE TZ HEAD AND CONCAVES MAY BE BUILT INTO ANY GYRATORY CRUSHER AT MODERATE COST. THUS REFITTED, THE MACHINE WILL HAVE 50% TO 75% GREATER CAPACITY AT SMALLER THAN THE PREVIOUS MINIMUM SETTING.

OUR REPRESENTATIVE WANTS TO TALK TO YOU! WRITE, PHONE OR WIRE FOR HIM, TODAY, TO

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"A Single Breaker May Recede— but The Tide Is Coming In!"

Action is the price of progress. Effective action means sustained product improvement and consumer education. This in turn requires expert assistance.

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As far as the eye can tell by observing the above photo, the thirteen drill holes are acting together to break the face of rock down uniformly. This simultaneous action helps breakage. Furthermore, Cordeau-Bickford gives you a detonator which is insensitive to friction or ordinary shock.

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